

When prosody matters!
Developing word segmentation abilities in
European Portuguese learning infants

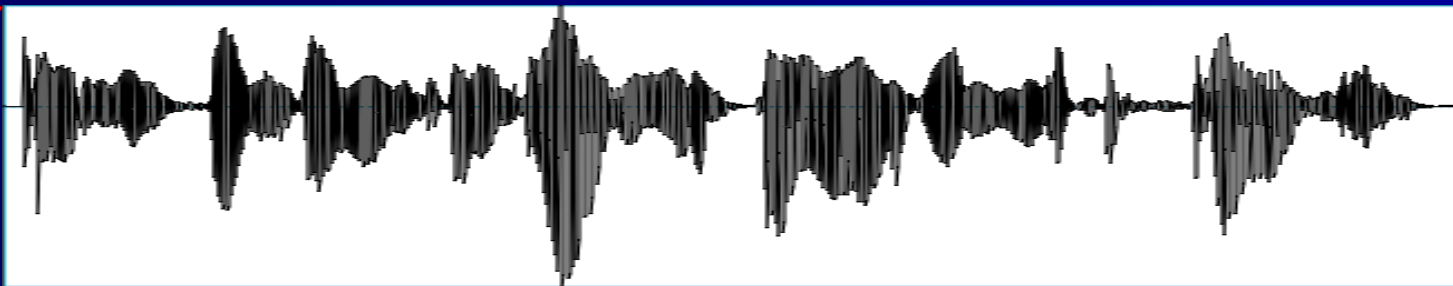
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Introduction

The word segmentation problem: when and how infants begin to segment word-like forms from the continuous speech stream?

édifícilencontrarumapalavranestafrase

CHALLENGE !



- Early word segmentation plays a crucial role in language acquisition (i.e., word learning, syntax – Newman et al., 2006; Singh et al., 2012)

Introduction

- Segmentation abilities in typically developing infants have been shown to vary across languages (e.g., Jusczyk & Aslin, 1995; Jusczyk et al., 1999; Seidl & Johnson, 2006; Hohle & Weissenborn, 2003, 2005; Bosch et al, 2013; Nazzi et al., 2006; Mersad et al., 2010; Nazzi et al., 2014)

	Monosyllabic	Bisyllabic	
		Trochaic	Iambic
English	7.5m	7.5m	10.5m
German	7-9m	9m	11m+
Spanish/Catalan	6m		
French	7.5m?	-	16m?/8m?

Introduction

- **Rhythmic properties** of a language (i.e., stress based, syllable based) may be utilised to begin segmenting continuous speech – what the infant relies on (Nazzi et al. 2006)
- Word position may be crucial also due to prosody: Words at **utterance edges/boundaries** easier to segment than those in the middle (Seidl & Johnson, 2006; Johnson et al., 2014)
 - Edge provides particularly **salient cues** e.g. duration and pitch cues

Language	Rhythm	Unit	Edge
English	Stress-timed	Word	earlier
German	Stress-timed	Word	
Spanish	Syllable-timed	Syllable	

Present study

- First attempt to study emerging segmentation abilities in European Portuguese (EP) learning infants
- **EP rhythm** displays both stress and syllable timing properties, unlike English or Spanish (Frota & Vigário 2001)
- Also, unlike other languages, EP provides **strong cues to high prosodic phrase boundaries and word boundaries**, but not to lower phrase boundaries (Vigário, 2003; Frota 2014)

Aims

- Identify at what point in development segmentation abilities emerge
- Investigate whether **prosody** constrains early word segmentation abilities in EP in comparison with other languages
 - **Monosyllabic segmentation** earlier/later
 - Effect of **prosodic salience** (prosodic boundaries)

Two studies

EP learning infants' ability to segment **monosyllabic** word forms

STUDY 1

5-6 months and 8-9
months

STUDY 2

12 months

Method – Study 1

Participants

- 5-6 months:
 - 20 infants from monolingual homes in the Lisbon area (11 boys, mean age 6m 3d, range 4m 19d – 7m 11d)
 - 5 infants excluded due to fussiness (1), risk of autism (1), not needed (3)

- 8-9 months:
 - 20 infants from monolingual homes in the Lisbon area (12 boys, mean age 9m 2d, range 7m 27d – 10m 8d)
 - 0 infants excluded

Method – Study 1

Materials

- 4 monosyllabic pseudo words (CVC/CVG)
 - Ful, Queu, Pis, Sau
- 2 passages constructed for each word, one for middle and one for end sentences



Less Prominent

Internal to the
Intonational Phrase (IP)

A Marta pôs o seu ■ na mesa.
Fizemos festas ao ■ vermelho.
Nunca comi ■ com morangos.
O Tó desenhou um ■ bonito.
Conheço ■ doce do Algarve.
Eles disseram ■ muitas vezes.



Prosodically
Prominent

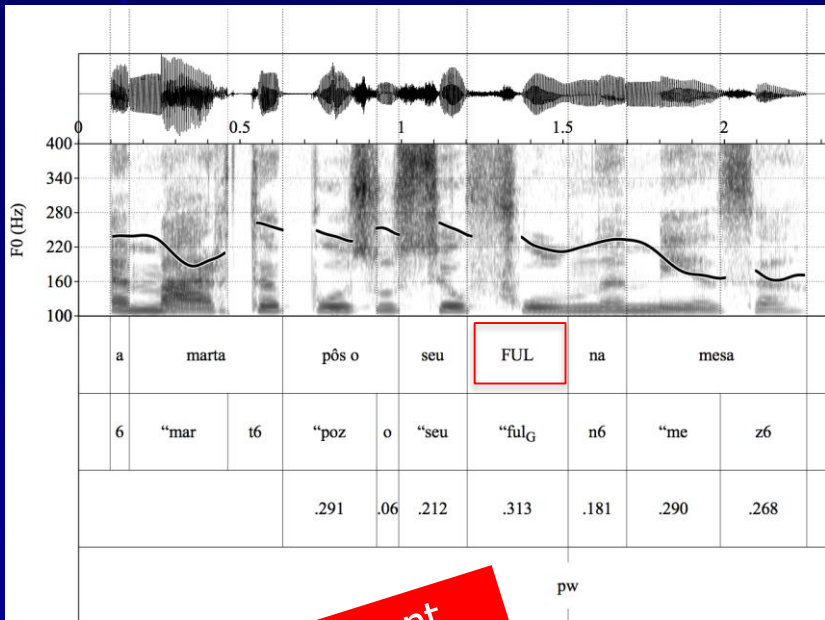
Final Intonational Phrase
edge (=sentence)

Os vizinhos brincam com o teu ■.
Estão sempre a falar-nos do ■.
Elas viajavam muito de ■.
Os anões adoram bolachas e ■.
Quero agradecer tudo ao ■.
A Dora anda no seu grande ■.



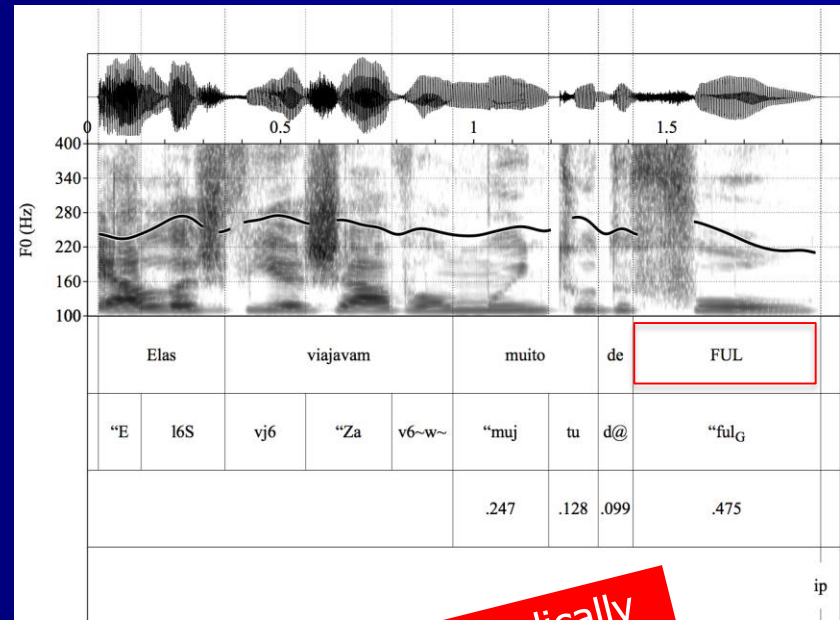
Method – Study 1

Internal to the
Intonational Phrase (IP)



Less Prominent

Final Intonational Phrase
edge (=sentence)



Prosodically
Prominent

Procedure: modified version of the Visual Habituation Paradigm (Stager & Werker, 1997; Altvater-Mackensen & Mani, 2013)



Method Study 1

Familiarisation

Alternating trials

25 secs accumulated
listening time to each

Passage 1 – End

Passage 2 – mid



Test

Block 1

Randomised order

Word 1 – familiar end

Word 2 – familiar mid

Word 3 – novel

Word 4 – novel

Block 2

Randomised order

Word 1 – familiar end

Word 2 – familiar mid

Word 3 – novel

Word 4 – novel

Block 3

Randomised order

Word 1 – familiar end

Word 2 – familiar mid

Word 3 – novel

Word 4 – novel

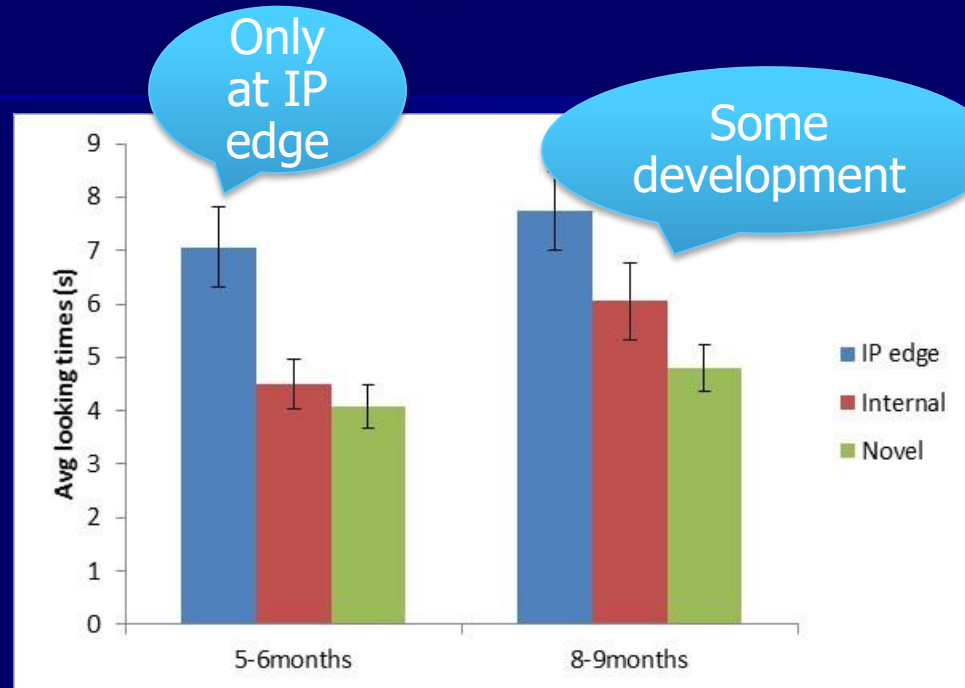


Trials continue until infant looks away for more than 2 consecutive seconds, or the sound file ends

Segmentation demonstrated by longer looking times to familiar word forms compared with novel

Results Study 1

Internal collapses lower prosodic boundary with just a word boundary



5-6 months:

- Significant effect of item status ($F(2,38) = 13.24, p < .001, \eta^2 = .41$).
 - end and middle ($t(19) = 3.38, p < .01$)
 - end and distracter ($t(19) = 4.72, p < .001$)
 - middle and distracter ($t(19) = .91, p = .37$).

8-9 months:

- Significant effect of item status ($F(2,38) = 16.72, p < .001, \eta^2 = .47$).
 - end and middle ($t(19) = 3.44, p < .01$)
 - end and distracter ($t(19) = 6.71, p < .001$)
 - middle and distracter ($t(19) = 2.12, p < .05$).

Method – Study 2

Participants

- 12 months (medial IP):
 - 20 infants from monolingual homes in the Lisbon area (10 boys, mean age 12m 2d, range 10m 24d – 13m 19d)
 - 2 infants excluded due to fussiness
- 12 months (medial PW):
 - 20 infants from monolingual homes in the Lisbon area (11 Boys, mean age 12m 10d, range 10m 15d– 14m 22d)
 - 3 infants excluded, 2 due to fussiness, 1 experimenter error

Method Study 2

Materials

- Same 4 monosyllabic pseudo words
 - Ful, Queu, Pis, Sau

Sentence internal
Intonational Phrase edge

Prosodically
prominent

As rãs gostam de [], em vez de musgo fresco.
Comprado o [], voltamos ao parque.
Desde que viu o [], não quis brincar mais.
Oferecemos-te [], mas ficaste triste.
Quanto à luz [], nunca foi testada.
Vocês prendem o [], porém ele fugiu.

NO
pause



- Procedure similar as for younger age groups
 - Only familiarised with words in middle of sentences

Method Study 2

Materials

- Same 4 monosyllabic pseudo words
 - Ful, Queu, Pis, Sau

Non-prominent internal position, with absence of any phrase boundary

NOT
Prominent

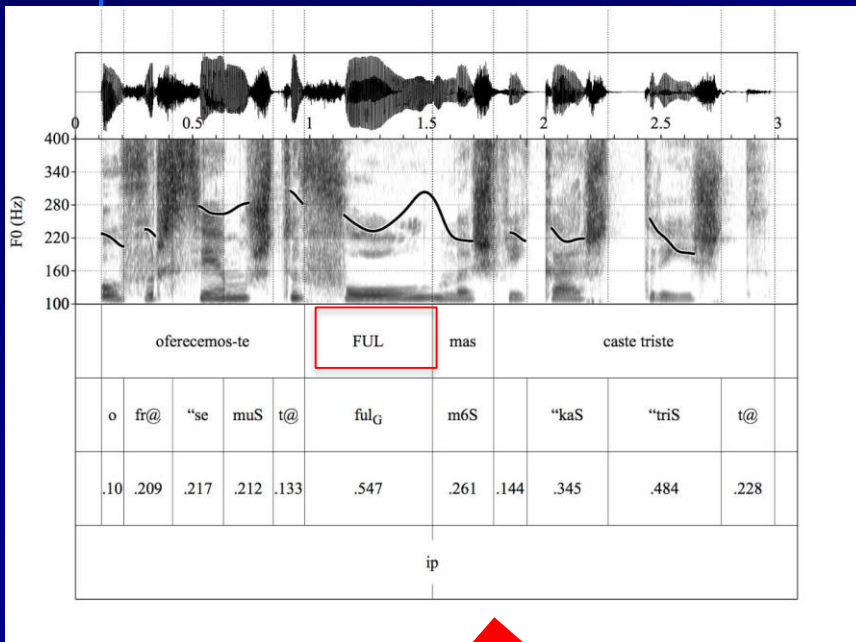
A caixa contém **ful** vermelho na tampa.
Aquele grande **ful** branco é da Quica.
Comeram muito **ful** doce na praia.
Hoje vi um **ful** castanho mas duro.
O amigo do **ful** português fugiu.
O outro **ful** branco foi de mercedes.

- Procedure similar as for younger age groups
 - Only familiarised with words in middle of sentences



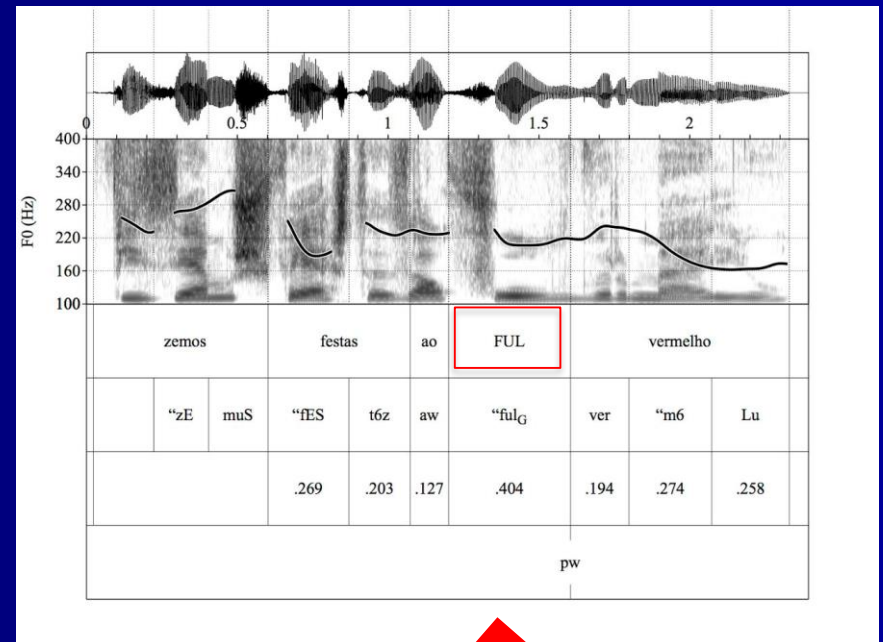
Method – Study 2

Sentence internal
Intonational Phrase edge



Prosodically
Prominent

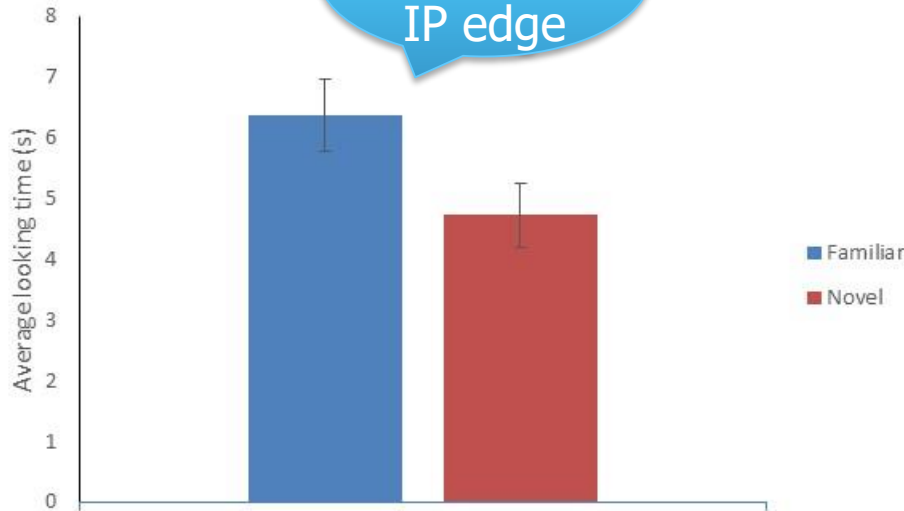
Non-prominent internal
position, no phrase boundary



NOT
Prominent

Results Study 2

At
internal
IP edge

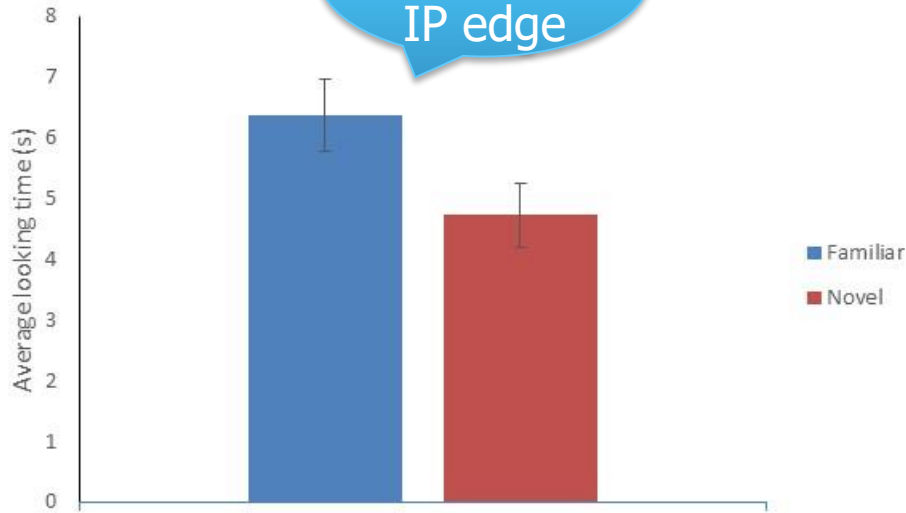


Similar behaviour,
segmentation wise, to 5-6
month olds at final IP
boundaries (=sentence edge)

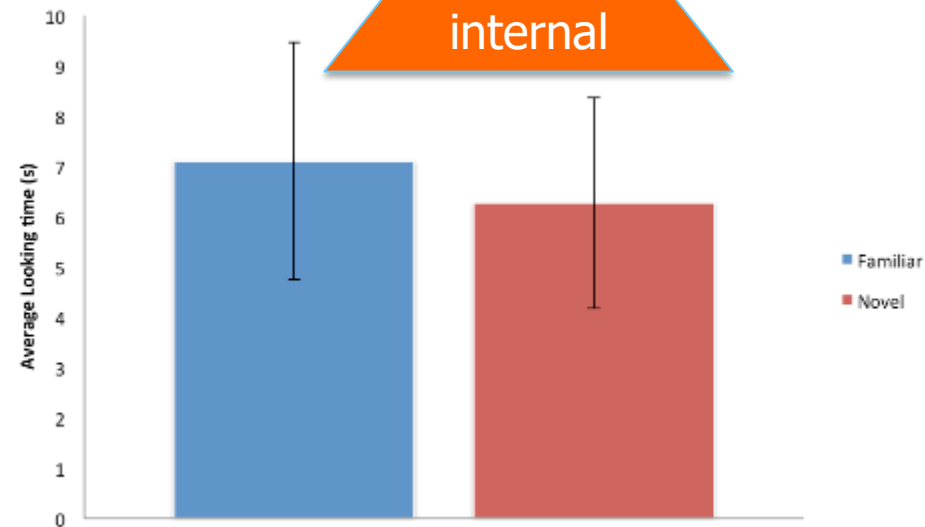
- Significant effect of item status - $F(1,18) = 23.6$, $p < .001$, $\eta^2 = .57$

Results Study 2

At
internal
IP edge



No!
Plain
internal



- Significant effect of item status - $F(1,18) = 23.6$, $p < .001$, $\eta^2 = .57$

- No significant effect of item status - $F(1,18) = 1.776$, $p > .1$, $\eta^2 = .090$

Conclusions

- EP learning infants at 5-6 months are able to segment continuous speech **only when the word is located at the high prosodic edge (IP boundary, the end of the sentence)**
 - In line with recent findings for English learning infants, but against those for Spanish/Catalan infants showing segmentation at 6 months regardless of prosody
- At 8-9 months, EP infants start to segment words in the middle of sentences (lower boundaries), but still demonstrate an advantage for words at the end of sentences

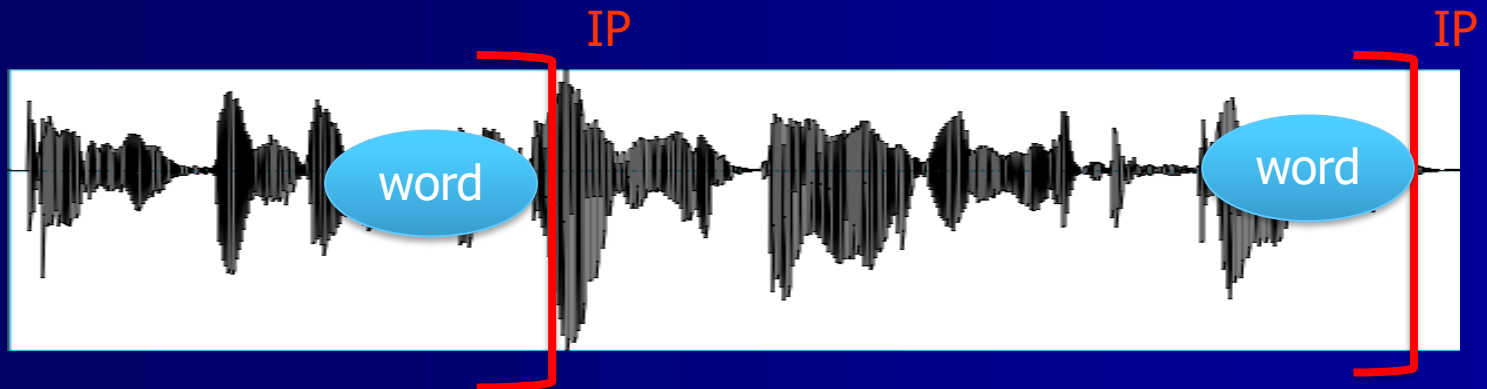
Conclusions

- Portuguese 12-month-old infants are able to segment words in **sentence medial position, when target word precedes a IP boundary** (despite the absence of a pause)
- This shows a sensitivity to prosody in early segmentation, beyond the edge vs. internal position



Prosody matters!

Prosody constrains the emergence and development of early segmentation in EP, in the first year



Thanks to all the infants, families and nurseries that have taken part in these studies.

Obrigado!

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Conclusions

- These findings add to our existing knowledge of the emergence of segmentation abilities
 - What cues constrain, or are utilised, during the development of this ability.
- New findings in a prosodically 'atypical' language, EP, not previously studied for word segmentation.